Deployment of Privacy-Preserving Machine Learning for Political Polling in the 2024 Presidential Election

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Traditional Political Polling

- Data collection takes time
- Data collection is human-intensive
- Poor geographic and temporal coverage

West Virginia 2024 Presidential Election Polls

Harris vs. Trump

Source	Date	Sample	Harris	Trump	Other
Research America	8/30/2024	400 LV ±4.9%	34%	61%	5%

Michigan 2024 Presidential Election Polls

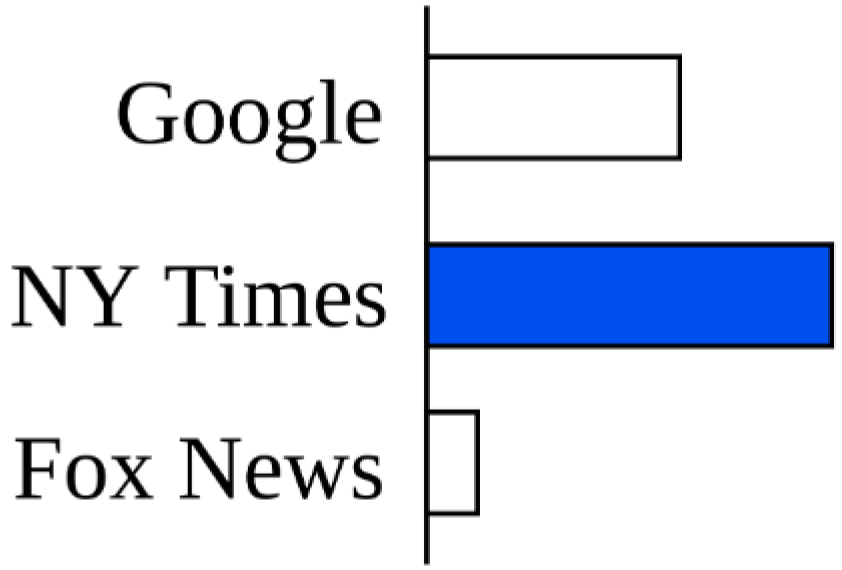
Instantly compare a poll to prior one by same pollster

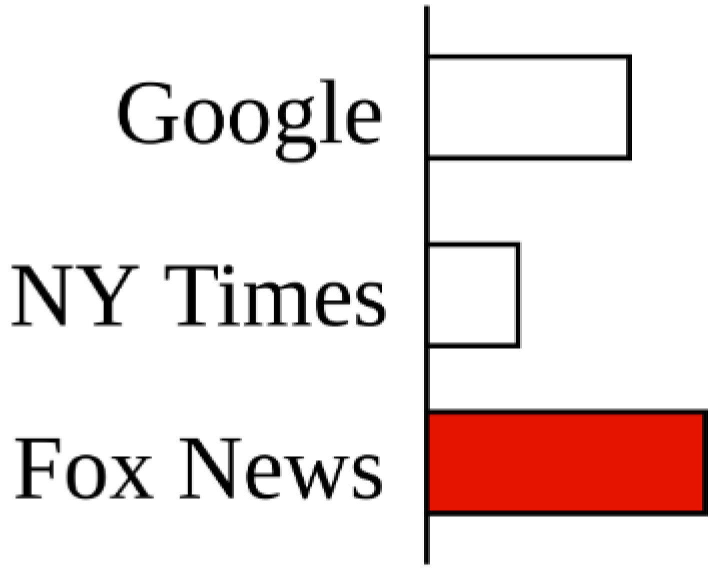
Harris vs. Trump

Source	Date	Sample	Harris	Trump	Other
Average of 23 Polls†			48.6%	46.8%	-
FAU / Mainstreet	11/04/2024	713 LV	49%	47%	4%
Emerson College	11/04/2024	790 LV ±3.4%	50%	48%	2%
Research Co.	11/04/2024	450 LV ±4.6%	49%	47%	4%
InsiderAdvantage	11/03/2024	800 LV ±3.7%	47%	47%	6%
Trafalgar Group	11/03/2024	1,079 LV ±2.9%	47%	48%	5%
MIRS / Mich. News Source	11/03/2024	585 LV ±4%	50%	48%	2%
NY Times / Siena College	11/03/2024	998 LV ±3.7%	47%	47%	6%
Morning Consult	11/03/2024	1,108 LV ±3%	49%	48%	3%
AtlasIntel	11/02/2024	1,198 LV ±3%	48%	50%	2%
Redfield & Wilton	11/01/2024	1,731 LV ±2.2%	47%	47%	6%
The Times (UK) / YouGov	11/01/2024	942 LV ±3.9%	48%	45%	7%
EPIC-MRA	11/01/2024	600 LV ±4%	48%	45%	7%
Marist Poll	11/01/2024	1,214 LV ±3.5%	51%	48%	1%
AtlasIntel	10/31/2024	1,136 LV ±3%	49%	49%	2%
Echelon Insights	10/31/2024	600 LV ±4.4%	48%	48%	4%
MIRS / Mich. News Source	10/31/2024	1,117 LV ±2.5%	47%	49%	4%
UMass Lowell	10/31/2024	600 LV ±4.5%	49%	45%	6%
Washington Post	10/31/2024	1,003 LV ±3.7%	47%	46%	7%
Fox News	10/30/2024	988 LV ±3%	49%	49%	2%
CNN	10/30/2024	726 LV ±4.7%	48%	43%	9%
Suffolk University	10/30/2024	500 LV ±4.4%	47%	47%	6%

Web Browsing for Political Polling

- Can website visits predict political leanings?
- Example - news websites
- More data
- Fully automated





Prior Work

- Web browsing behavior can predict voting results
- Quantifying the 'Comey letter' (Comarela et al.)
- Social media referrals are the best signal

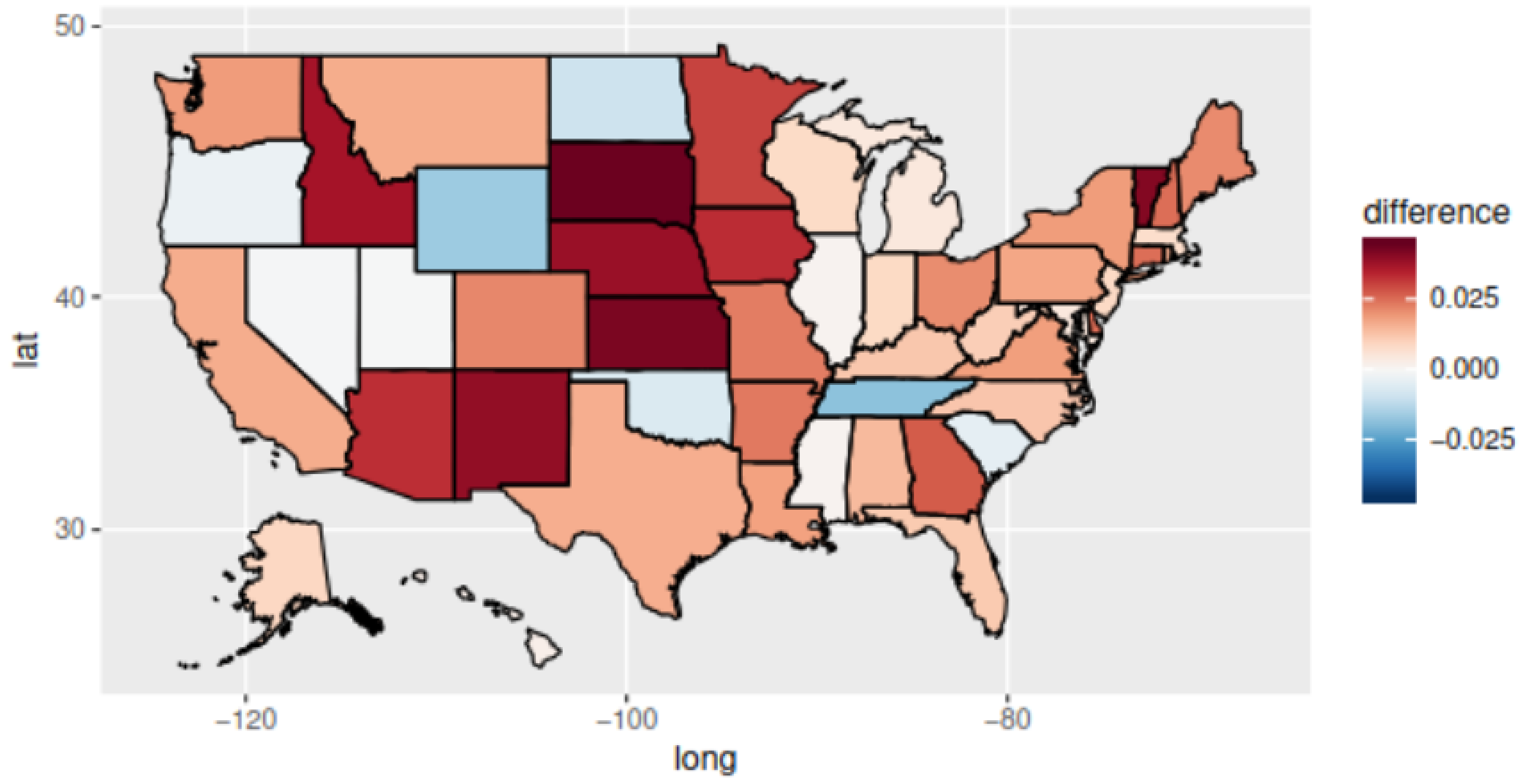


Figure 8: Impact of the 'Comey letter' at the state level.

Two Approaches to Political Polling

Traditional Polling	Web Behavior Analysis
Slow	Immediate
Expensive	Cheap
Coarse-grained insights	Fine-grained insights

VS

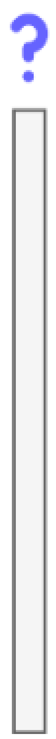
What about privacy?

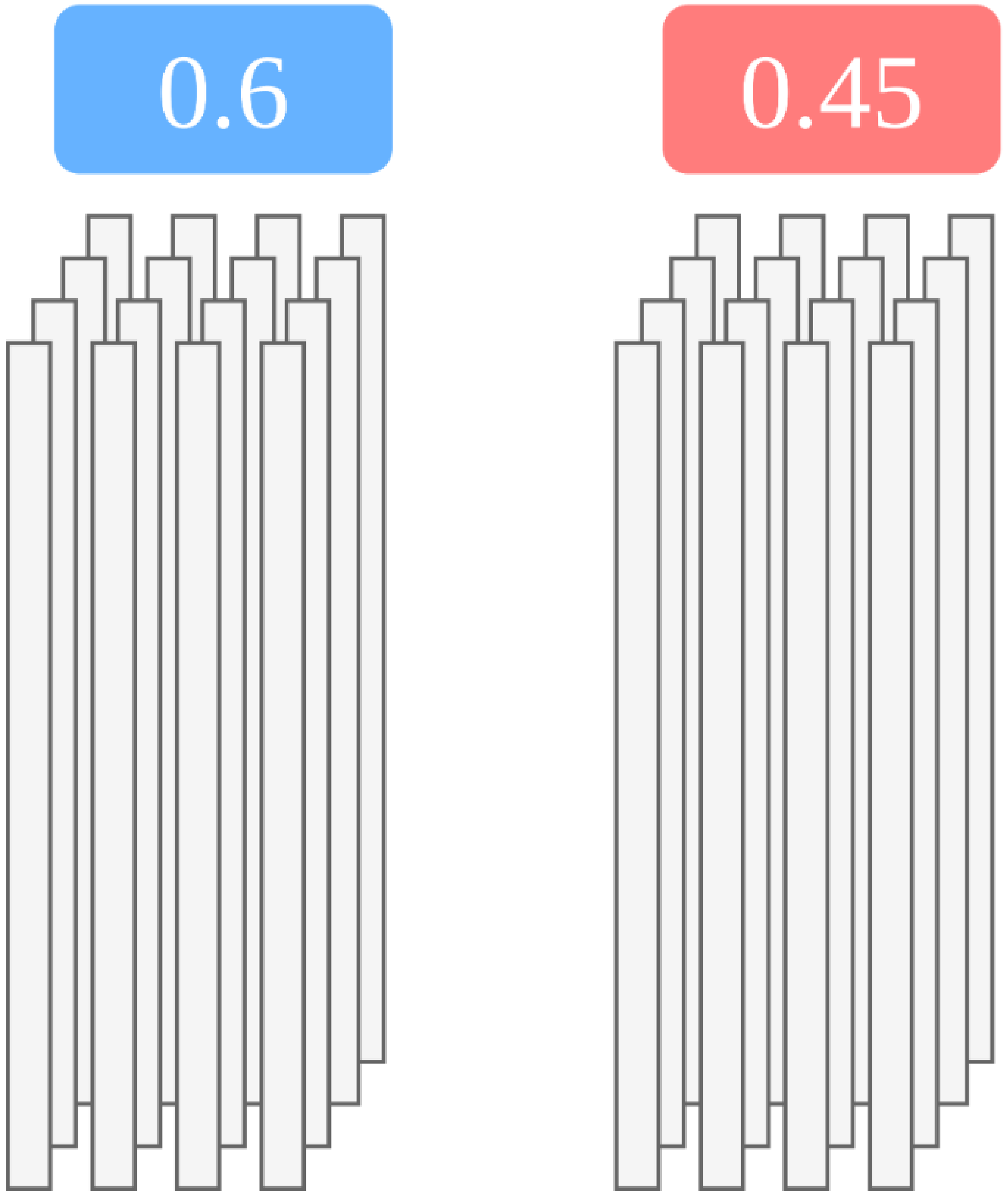
Our Contributions

- We built a system for securely predicting political preferences from web browsing data
- We collected and analyzed data from almost 8000 unique users
- All analysis took place under MPC

Learning from Label Proportions (LLP)

- Each user uploads an *unlabeled* 1,034-element vector every day
  - Number of visits to the top 517 sites
  - Number of times referred to the top 517 sites
- Unlabeled vectors are grouped by state
- Each state has a ground-truth label
- Train on aggregate ground truth
- Predict on an individual level



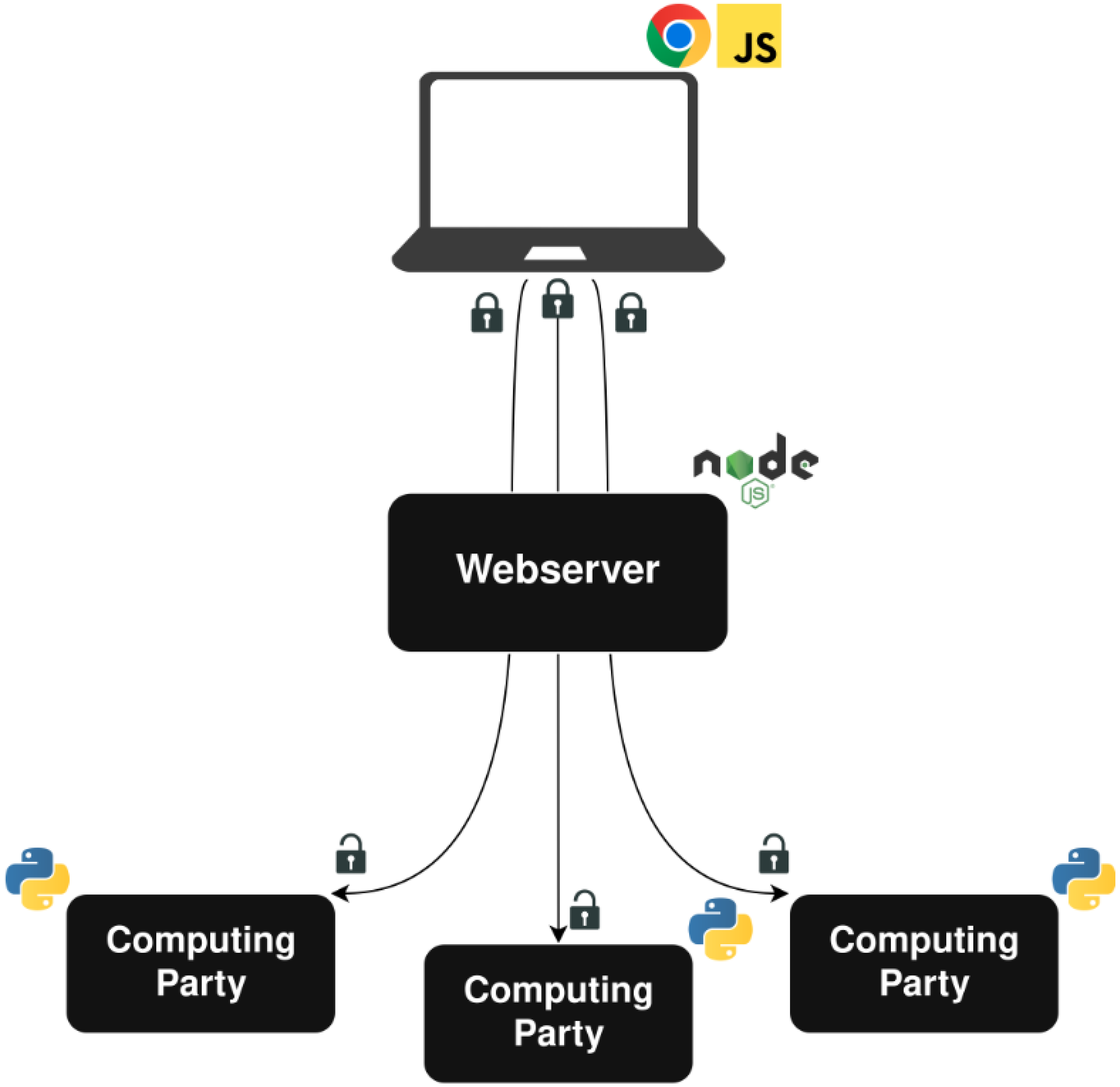


System Design

Client Plugin

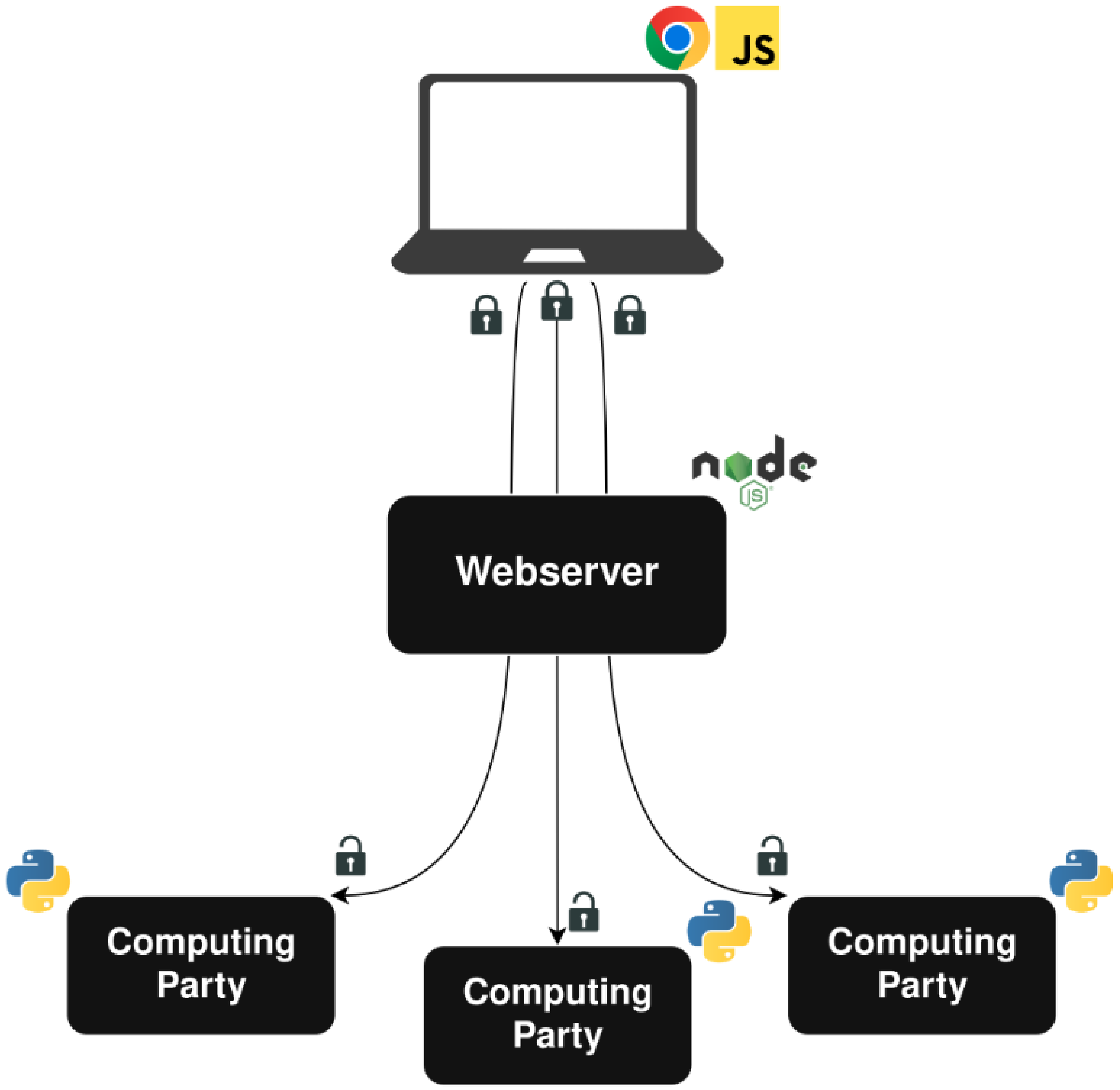
Webserver

MPC Backend



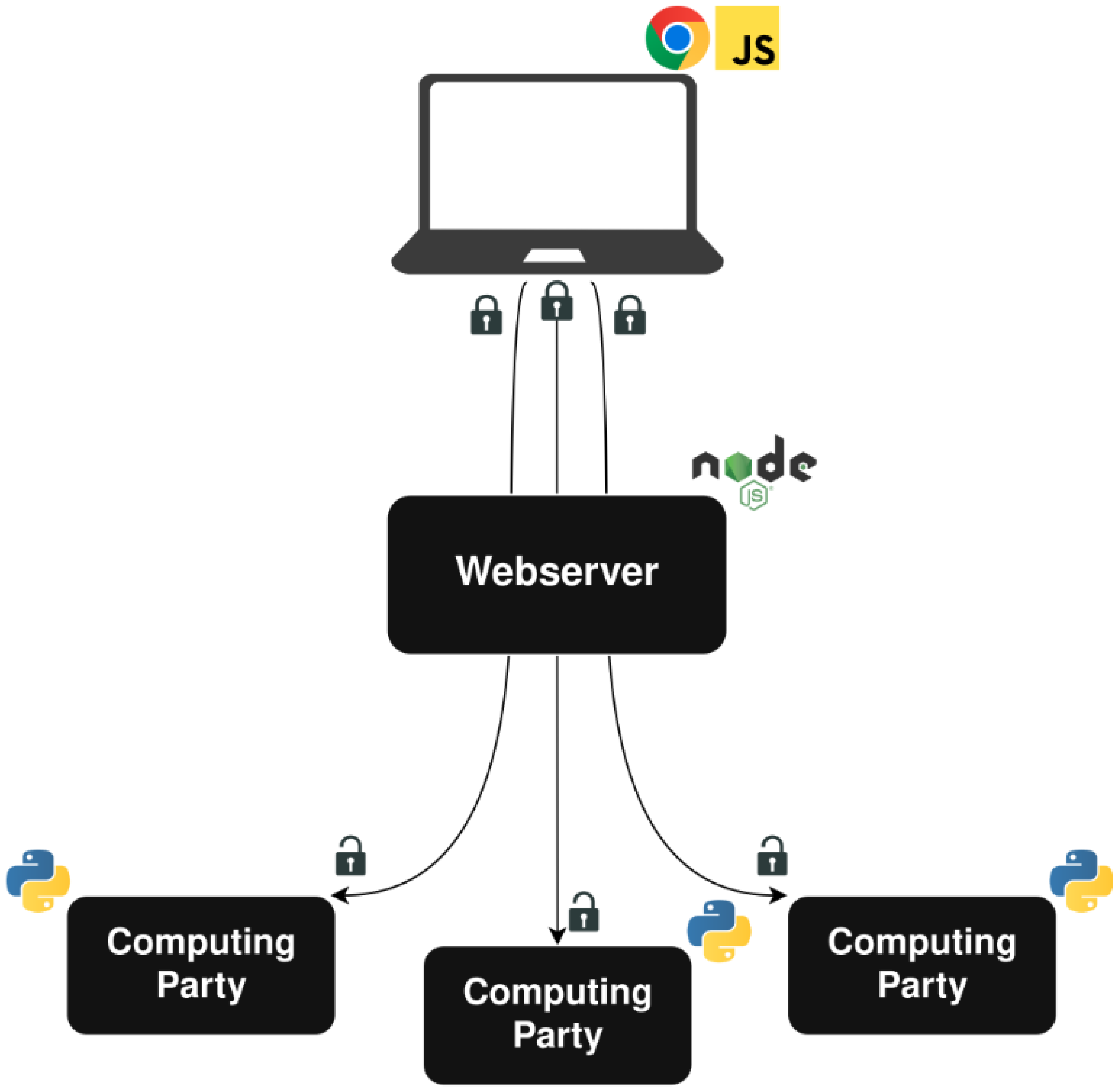
Client Plugin

- Custom-built Chrome plugin to monitor browsing
- Daily data uploads of secret-shared histograms
- Client-side secret sharing and encryption
- Implementation is open source



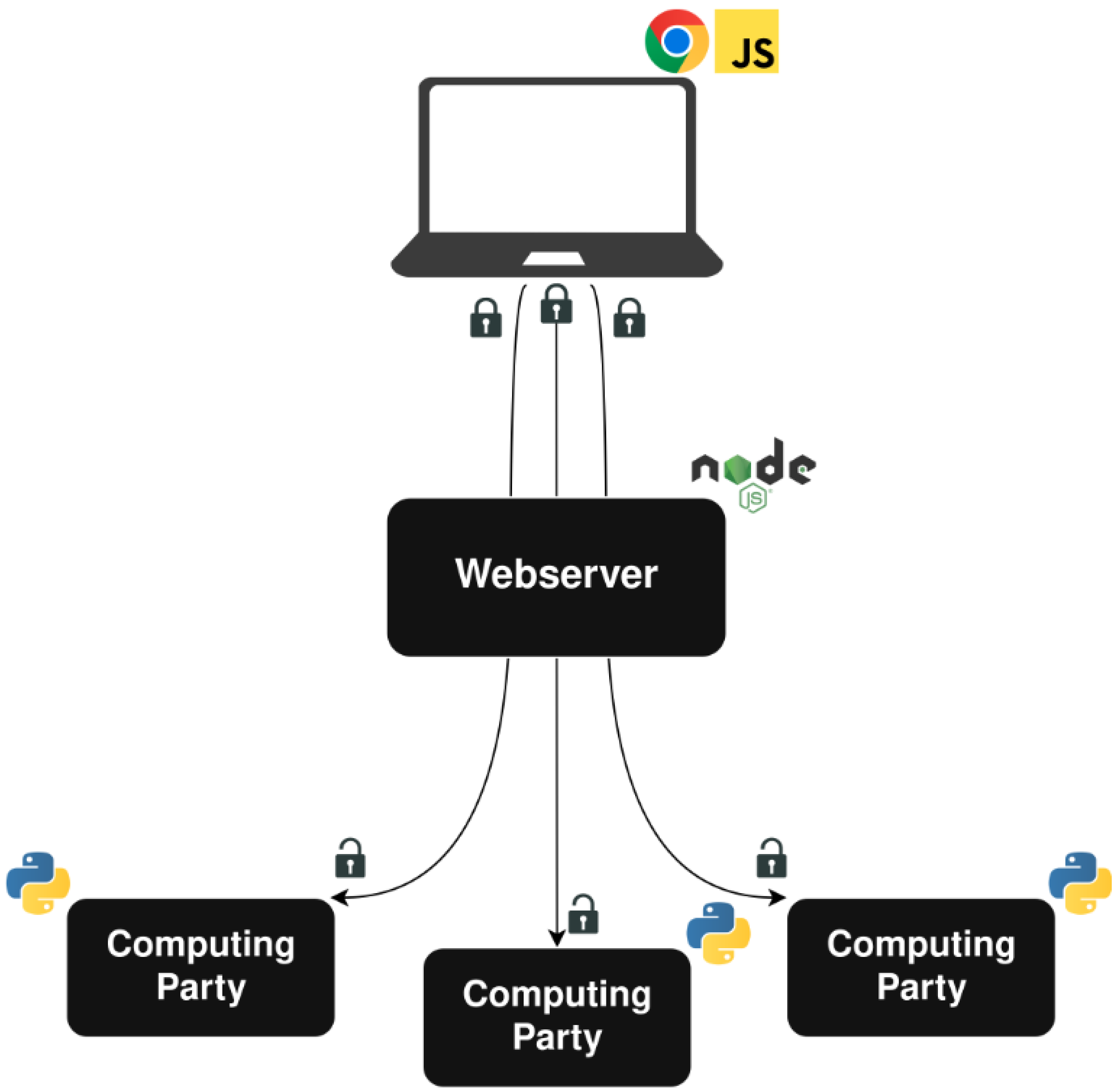
Webserver

- Simplifies interaction with clients
- Collects basic metadata
- Never sees any private data

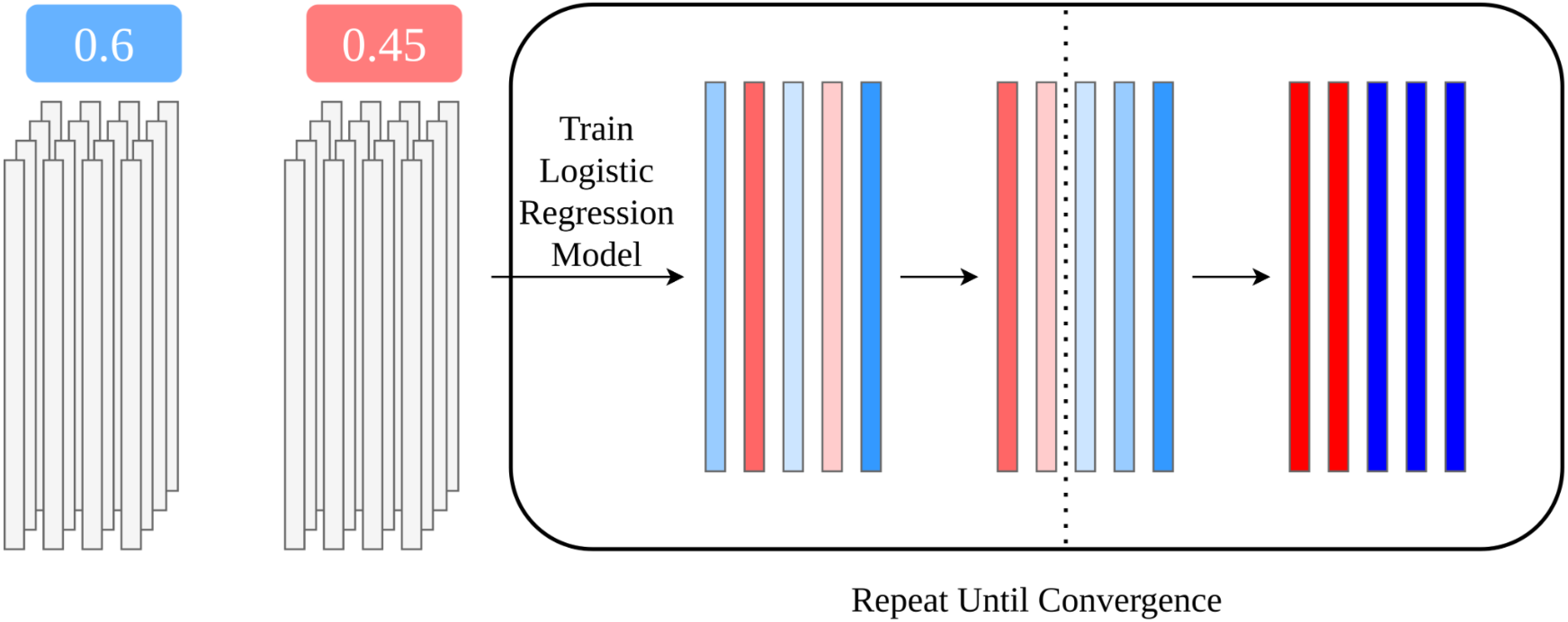


MPC Backend

- We use and augment the CrypTen library
- We implemented an algorithm for LLP under MPC
- Three party computation with an honest majority



The Plaintext Algorithm



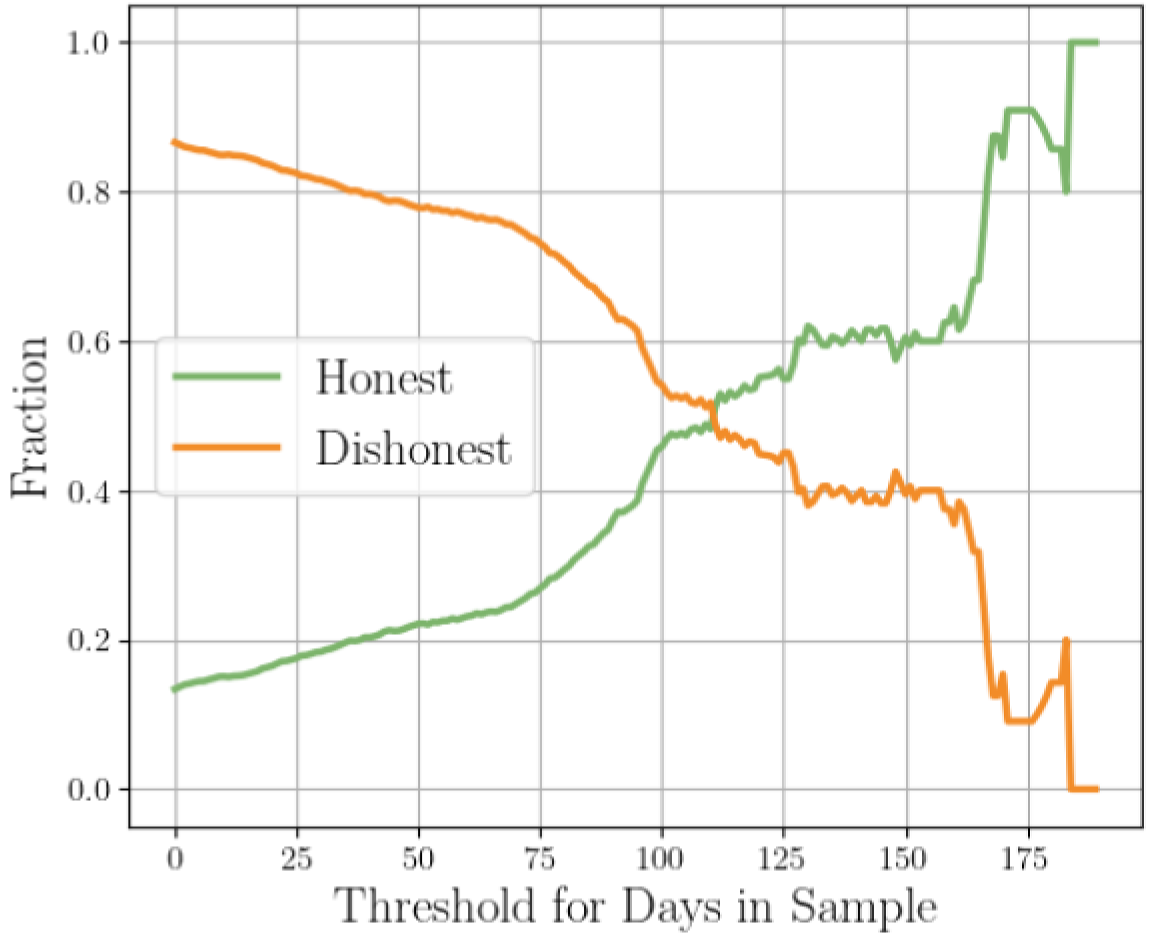
Implementation in MPC

- Initial label assignment can be performed in plaintext
- Training a logistic regression model is supported by CrypTen
- Computing thresholds requires oblivious sorting
- Updated label assignment and convergence checking use secure comparisons
- Practically efficient
- Code will be open source in the future

Lessons Learned and Future Directions

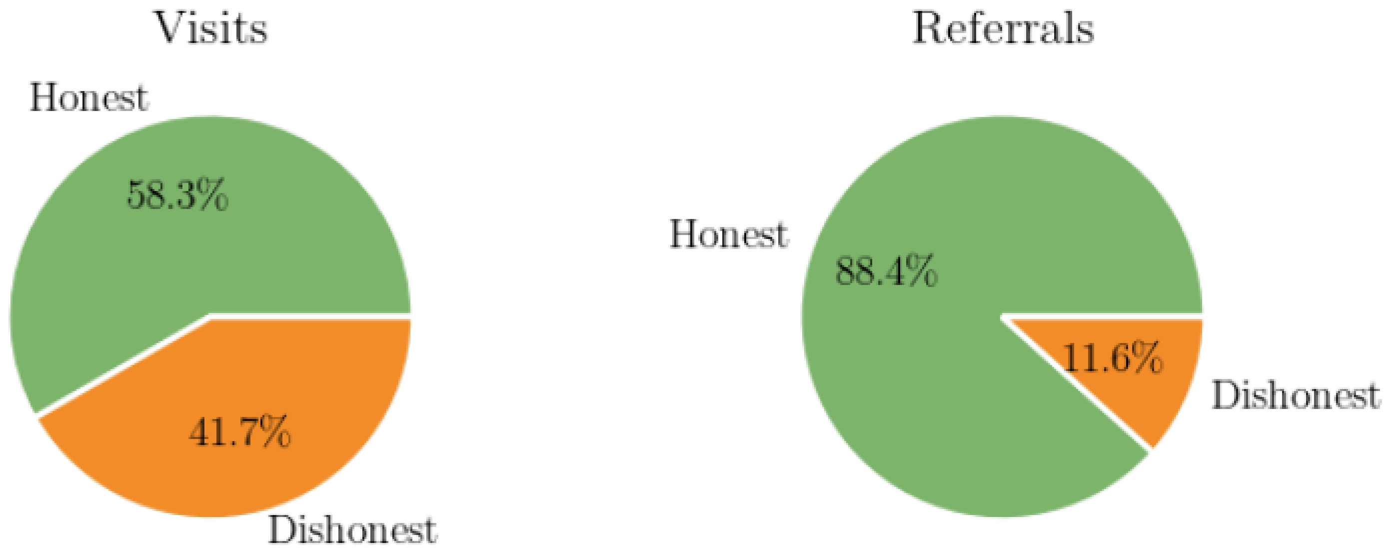
Data Integrity Matters

- Trouble with dishonest reporting of location
- Validation with IP addresses and geolocation
- State-level results are concerning
- Digging deeper on the data
  - Users in the sample for longer are more honest
  - Honest users contribute much richer data



Lesson: Validating and enforcing user honesty should be a priority in future deployments.

Lesson: Our learning process is surprisingly robust to dishonest users.



Strengthening the Threat Model

- AWS as a single point of failure
- Reduce or eliminate trust in the core computation
- Anonymous payments

Thank You!

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